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(54) Title: NATURAL GUM REPLACER

## (57) Abstract

The converted starch used as a natural gum replacer is made from a waxy starch or a dull waxy starch by extruding the starch through a co-rotational twin screw extruder which imparts 600 to 1050 KJ/Kg of specific mechanical energy to the starch. The starch has a residence time in the extruder barrel of 20-35 seconds and the die of the extruder has a temperature of 175-225 °C. The converted starch has a DE of less than 1 and produces aqueous solution at 10 % solids having a clarity greater than 80 %T after three days of storage.

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NATURAL GUM REPLACERBACKGROUND OF THE INVENTION1. Field of the Invention

This invention relates to starch and, more particularly, to the use of a converted starch as a replacement for natural gums in food formulations.

2. Description of Related Art

5 The modification of starch to improve or change its properties is accomplished in a number of ways. Typical modified starches include cross-linked starches, acetylated starches, hydroxypropylated starches and phosphorylated starches. These modifications typically 10 add chemical constituents to the polymeric structure of the starch and are often referred to as chemically modified starch. There are also physical modified starches, commonly called converted starches. Converted 15 starches are made by using chemical and/or physical means to weaken or destroy the granular structure of the starch without the addition of major chemical groups to the starch polymer. The conversion process usually causes some hydrolysis of the alpha 1-4 and/or alpha 1-6 bonds of the starch polymers. According to Wurzburg, O.B. 20 "Converted Starches", Modified Starches: Properties and Uses edited by Wurzburg, O.B., CRC Press (1986), pgs. 17-40, there are three broad classes of commercial converted starches: acid conversions or acid-modified starches (also known as thin boiled or water fluidity starches), 25 oxidized or hypochlorite-modified starches (also known as bleached starches), and pyroconversions or dextrinizations often referred to simply as dextrins. It is also known that converted starches can be made by an extrusion process, see for example, Orford, P.D. et al. 30 "The Functional Properties of Extrusion-cooked waxy-Maize

Starch", Journal of Cereal Science 18 (1993) 277-286. Depending on the conversion process employed, the properties of the converted starch will vary widely not only in their physical and chemical properties but also in their organoleptic properties.

5 One of the problems associated with converted starches, and especially dextrins, is their poor taste. Also, the clarity of an aqueous solution of a dextrin and a thin boiled starch tends to be poor, making them  
10 unacceptable for use in food applications where clarity is important.

15 In certain food applications, not only is clarity important, but so is stability of clarity, i.e. the clarity must not decrease over time. Dextrins and thin boiled starches are known for poor clarity stability. Another attribute important in food applications is the absence of granular structure. Presence of granular structure produces an undesirable granular flavor and mouth feel as well as reducing the clarity of any  
20 solution containing the same. Dextrins and thin boiled starches often possess a granular structure making them unacceptable in food applications. Another important attribute in food formulations is the ability to form a film and adhere to a substrate. This attribute is  
25 especially advantageous in candy coating.

30 In food formulations, natural gums such as pectin, gelatin, gum arabic, guar gum, agar, locust bean, carrogeenan and xanthan gum are used to bind water, provide increased viscosity, suspend solids, stabilize emulsions and retard ice crystal growth in frozen foods. Natural gums, however, tend to be expensive and are often not readily available in the marketplace in large quantities. There is a need to find a composition that can be used as a gum replacement in food formulations.

35 SUMMARY OF THE INVENTION

It has been found that a converted starch made by extruding a high amylopectin starch can be used to

replace natural gums in a food formulation. This avoids the pitfalls previously mentioned with respect to natural gums.

5        Additionally, it has now been discovered that the converted, high amylopectin starch made by extruding a cross-linked, hydroxyalkylated high amylopectin starch can produce an aqueous solution of excellent clarity with long term stability. In fact, the converted high amylopectin starch made from a cross-linked, 10 hydroxyalkylated, high amylopectin starch can produce aqueous solutions with clarity and stability greater than aqueous solutions containing conventional converted starches or similar to low DE maltodextrins (DE 5).

15      In fact, it has been found that aqueous solutions of the converted, high amylopectin starch made by extrusion has surprising and unexpected clarity and stability when compared to aqueous solutions containing conventional converted starches, as well as a clean flavor compared to conventional converted starches. The converted, high 20 amylopectin starch made by extrusion has been found to have good film forming properties which makes it well suited for use in candy applications.

25      Broadly, the present invention is directed to a method for preparing a foodstuff wherein said foodstuff is prepared from a formulation containing a foodstuff, and a natural gum, the improvement comprising replacing at least a portion of said natural gum with water and an effective amount of a converted starch characterized by having a dextrose equivalent of below about 1, said 30 converted starch being obtained from a high amylopectin starch which has been extruded at a specific mechanical energy of about 600 to about 1050 Kj/Kg, said converted starch being devoid of granular structure, said converted starch producing an aqueous solution when added to water 35 having an initial clarity of at least about 80%T at about 10% solids, when measured spectrophotometrically at 650  $\mu\text{m}$  through 1 cm cell.

The converted, high amylopectin starch used in the present invention is obtained by extruding a granular high amylopectin starch having a total moisture content of about 15 to about 25% by weight through a co-  
5 rotational twin screw extruder wherein the exturder imparts a specific mechanical energy (SME) of about 600 to about 1050 KJ/Kg to said starch, said extruder having a barrel with a length to diameter ratio (L/D) of about 15 to about 20, said starch having a residence time in  
10 said barrel of said extruder of about 20 seconds to about 35 seconds, and a die temperature of about 175 to about 225°C. The resulting converted, high amylopectin starch has a measurable dextrose equivalent (DE) of less than about 1 and is completely devoid of granular structure.  
15 An aqueous solution of the converted, high amylopectin starch at 10% solids has an initial clarity of greater than about 80%T when measured spectrophotometrically at 650  $\mu\text{m}$ ; and a long term clarity of greater than about 80%T when measured spectrophotometrically at 650  $\mu\text{m}$ .

20 It has been found that the converted, high amylopectin starch has a number of uses in food. In one application it is used as a replacement for natural gums. Specifically, it has been used to replace natural gums in gelatin type puddings, in doughnut glazes, in clear  
25 pastry glazes, in ice cream, in yogurt, in sour cream, and in candy coatings. The converted, high amylopectin starch is especially useful for replacing carrageenan, agar and gum arabic.

30 It has been found that converted, high amylopectin starch has a number of characteristics which make it suitable as a gum replacement, namely, the converted, high amylopectin starch has been found to bind water, provide increased viscosity, suspend solids, and retard ice crystal growth in frozen foods.

35 In replacing natural gums, the converted, high amylopectin starch is preferably employed on about 1:1 to about 1:3 weight ratio for the natural gum. The

converted, high amylopectin starch is used to replace all or some of the natural gum.

It has also been found that the converted, high amylopectin starch can replace maltodextrins on about 5 0.5:1 to about 1:1 weight basis.

Furthermore, the converted, high amylopectin starch can be used in fried food coating, as a shellac in sauces and gravies, as glazes in frozen and non-frozen foods, and as a moisture barrier.

10 With respect to gelatin type desserts, the converted, high amylopectin starch is used to replace gelatin. A suitable formulation of a gelatin-like dessert is made with the converted, high amylopectin starch in an amount of about 5 to about 15% by weight and, more preferably, about 10% by weight. A sweetener in an amount of about 2 to about 25% by weight and, more preferably, about 5 to about 15% by weight is also incorporated into the desert formulations. Any conventional sweetener can be used to include artificial sweeteners. Preferably, a natural gum with gum gelling characteristics is employed in the gelatin-like dessert. Suitable gums include carrageenan, and locust bean with xanthan. The amount of natural gum is about 2% or less and, more preferably, about 1% or less. Good results are obtained with about 0.5% by weight natural gum. The remainder of the formulation is water. Typically, water is present in an amount of about 60 to about 80% and, more preferably, about 75% by weight.

30 The converted, high amylopectin starch can also be used to prevent ice crystal growth in ice cream and bind water (prevent weeping) in dairy products such as yogurt and sour cream. Heretofore, primarily gums and/or maltodextrins had been used in such applications.

35 The converted, high amylopectin starch can also be used to replace those gums and waxes used to clear coat candies. Conventionally, waxes such as carnauba wax is used to clear coat candies to make them shine. It has

been found that the converted, high amylopectin starch can be used to clear coat candy.

5 The clear coating of candies is done in a conventional way by making up an aqueous slurry containing the converted, high amylopectin starch and tumbling the candy in a pan. Subsequently, the coated candy is air dried.

10 It has also been found that the converted, high amylopectin starch adheres very well to nuts and prevents the migration of nut oil out of the nut into the candy coating, thus making the converted, high amylopectin starch a good coating for nut centers used in candy. Conventionally, gum arabic had been used in such applications.

15 In order to apply a coating comprising the converted, high amylopectin starch to nut centers, the nuts are tumbled in a pan and a slurry comprising the converted, high amylopectin starch is applied to the surface of the nuts. Then the coated nuts are allowed to 20 air dry.

#### DETAILED DESCRIPTION OF THE INVENTION

The converted, high amylopectin starch used in the present invention is made from a high amylopectin starch.

25 The term "high amylopectin starch" as used in the specification and claims means that the starch has an amylopectin content of about 80% and above when measured by a conventional Iodine binding technique. More preferably, the high amylopectin starch has an amylopectin content of about 95% and above and good 30 results have been obtained with starches having an amylopectin content of about 99% and above. Starches having such a high amylopectin content are conventionally referred to as waxy starches and root starches.

35 Starch is obtained from plants and suitable plants for obtaining high amylopectin starch include sorghum, rice, potato, tapioca and maize. Good results have been obtained with high amylopectin starch obtained from

maize.

It is known that there are a number of recessive mutant genes in starch bearing plants that have an effect on the properties of the starch to include the 5 amylopectin content of the starch. Preferably, the high amylopectin starch is extracted from a plant that has the triple recessive waxy gene or a triple dose of dull recessive gene combined with a triple dose of waxy recessive gene. Plants having the triple dose of waxy 10 genes are conventionally referred to as waxy, e.g. waxy rice, waxy sorghum, and waxy maize. Likewise, plants with the combined dull and waxy genotype are referred to as dull waxy, e.g. dull waxy maize. The starch obtained from these plants are likewise given a prefix based on 15 the genotype of the plant, e.g. waxy starch and dull waxy starch.

The converted, high amylopectin starch used in accordance with the present invention is preferably made from dull waxy starch or waxy starch with good results 20 having been obtained from dull waxy starch.

The granular starch which is fed to the extruder is preferably either an unmodified granular starch or a chemically modified granular starch. Suitable chemically modified granular starches for making the converted, high 25 amylopectin starch used in the present invention include etherified starches, cross-linked starches, acetylated starches, etherified, cross-linked starches, acetylated cross-linked starches, and phosphorylated monoester starches. These chemically modified starches which are 30 used as starting materials in the present invention are granular and made in a conventional manner using conventional chemical reagents.

Preferably, the converted, high amylopectin starch is made from a high amylopectin starch selected from the 35 group consisting of dull waxy corn starch, waxy corn starch, hydroxypropylated, crosslinked dull waxy corn starch and hydroxypropylated, crosslinked waxy corn

starch.

In order to etherify the high amylopectin starch, a slurry of starch is made up having about 5 to about 40% by weight starch. The pH of the slurry is adjusted to about 10 to about 12 preferably with sodium hydroxide. Next, an etherification agent such as ethylene oxide or propylene oxide is added to the slurry in an amount of about  $\frac{1}{2}$  to about 25% depending on the desired degree of substitution. The reaction conditions are held for about 5 to about 30 hours at about 70° to about 120°F. The slurry is then neutralized with any known acid, dewatered, washed and dried. The preferred etherification agent is propylene oxide such that a hydroxypropyl high amylopectin starch is used to make the converted starch of the present invention. The amount of the propylene oxide on the starch is preferably about 2 to about 4.5% and, more preferably, about 2.5%. The degree of substitution (DS) of the hydroxypropylated starch is about 0.056 to about 0.126 and, more preferably, about 0.060 to about 0.080. Good results have been obtained with a DS of about 0.070.

In order to crosslink the high amylopectin starch, a slurry of starch is made up of about 5 to about 40% by weight starch. The pH of the slurry is adjusted to about 8 to about 12 preferably with sodium hydroxide. Optionally, a salt may be added to the slurry to affect swelling of the granules. Then the slurry is reacted with a crosslinking agent such as phosphorous oxychloride, trimetaphosphate salt, or epichlorohydrin at about 70 to about 120°F for about  $\frac{1}{2}$  to about 5 hours. The length of time of the reaction will depend on the amount of crosslinking agent used and the specific crosslinking agent chosen. The preferred crosslinking agent is phosphorous oxychloride. Preferably, phosphorous oxychloride is used at levels of about 0.02 to about 0.06 and, more preferably, about 0.035 to about 0.04.

In order to acetylate the starch, a slurry of starch is prepared having about 5 to about 40% by weight starch. The pH of the slurry is then adjusted to about 8 to about 10 and an acetylating agent is added to the slurry such 5 as vinyl acetate or acetic anhydride. The acetylating agent is added slowly while maintaining the pH of the slurry. The reaction is continued for about  $\frac{1}{2}$  to about 5 hours at about  $80^{\circ}$  to about  $120^{\circ}$ F. Once the reaction is completed to the desired degree of substitution, the 10 slurry is neutralized, dewatered, washed and dried.

In order to make a starch phosphate monoester from an inorganic phosphate salt, the starch is first impregnated with a phosphate salt by suspending the mixing of the starch and the salt in an aqueous solution 15 and then drying the impregnated starch to a moisture content of about 10% by weight and heating the dried, impregnated starch to a temperature of about  $100^{\circ}$ C to about  $160^{\circ}$ C for a period of about  $\frac{1}{2}$  to about 6 hours. The pH of the dried impregnated starch should be about 5 20 to about 6.5. The preferred phosphate salt is sodium tripolyphosphate. Maximum phosphate on the starch is preferably below 0.4% by weight calculated as phosphorous.

When making the hydroxyalkylated crosslinked starch 25 and the acetylated crosslinked starch, the order of reaction is not critical. The starch can first be crosslinked and then either etherified or acetylated or the starch can be first either etherified or acetylated and then crosslinked.

The co-rotational twin screw extruder used to make 30 the converted, high amylopectin starch is operated in a manner such that the extruder imparts a specific mechanical energy of about 600 to about 1050 KJ/Kg to the starch as it passes through the barrel. More preferably, 35 about 700 to about 900 KJ/Kg of specific mechanical energy is imparted to the starch as it passes through the barrel.

The total moisture content of the feed starch is about 15 to about 25% by weight and, more preferably, about 20% by weight.

5 The twin screw is operated in a co-rotational manner, both screws turning in the same direction. The screws preferably rotate at about 300 to about 550 rpm and, more preferably, at about 500 rpm. The flow rate of the starch through the extruder is preferably about 225 to about 275 g/min and, more preferably, about 250 g/min.

10 Both the speed of the screws and the flow rate relate to the residence time of the starch in the barrel. If the residence time is too long, the starch will burn. If the residence time is too short, the starch will have some granular structures remaining. Specifically, the 15 residence time of the starch in the barrel is about 20 to about 35 seconds and, more preferably, about 25 to about 30 seconds.

20 The length to diameter ratio (L/D) of the barrel in the extruder is about 15 to about 20 and, more preferably, about 17.

25 At least two specific screw designs have been found to work very well for making the converted, high amylopectin starch. The screw design is such that the screw configuration varies along the length of the barrel. Both screw designs were used with a Clextral BC45 Extruder, manufactured by Clextral Inc. of Tampa, Florida. Specifically, the BC45 has a barrel suited for twin screws that co-rotate wherein the screws are self-wiping and self-cleaning. The barrel length is 30 approximately 1.2 meters and houses two screws having a screw diameter of about 55.5mm with a center to center screw distance of about 45mm. Two specific screw designs were found to provide good results. One of these, the T3 design, was found to give better results than the other, 35 the T2 design.

The two screw designs for the Clextral Extruder from feed to die are as follows:

T2 DESIGN

	<u>Section</u>	<u>Screw Section</u>	<u>Pitch (mm)</u>	<u>Length (mm)</u>
5	1	T2F	66	200
	2	C2F	66	200
	3	C2F	50	200
	4	C2F	50	100
	5	C2F	33	100
10	6	C2F	33	100
	7	C2F	33	100
	8	C2F	33	100
	9	BLB	Neg.	50
	10	C2F	15	50

T3 DESIGN

	<u>Section</u>	<u>Screw Section</u>	<u>Pitch (mm)</u>	<u>Length (mm)</u>
20	1	T2F	66	200
	2	C2F	66	200
	3	C2F	50	200
	4	C2F	50	100
	5	C2F	33	100
25	6	C2F	33	100
	7	BLB	Neg.	50
	8	C2F	33	100
	9	BLB	Neg.	50
	10	C1F	15	100

As can be seen, both the screw configuration and the screw pitch varied along the entire length of the barrel.

The T2F screw section has a trapezoidal shaped channel which means that the bottom of the channel makes a sharp angle with the wall of the flight, hence the name trapezoidal. Additionally, it has two screw elements or two separate screw threads in the section. These two threads are set off by 180° from each other. The pitch for each thread is given in the tables above. It will be recognized that the distance between the flight of one

thread and the flight of the other thread is half of the pitch distance; the two threads are evenly placed, one inside the other.

5 The C2F screw section has a curved or arched transition between the wall of the flight and the bottom of the channel. It has two separate threads, like the T2F, which are set off by 180° from each other. The pitch for each thread is the same and the distance between the flight of one thread and the flight of the 10 other thread is half the pitch distance.

15 The BLB section acts as a kneading element and is considered to have a negative or reverse pitch. The BLB is made up of bilobal elements having a figure-eight cross-section and a thickness of 12.5mm. The bilobal sections are arranged to provide a reverse or negative pitch to the section.

20 The C1F section is a screw which has only one thread for the section and a channel with a cross-section that is curved at the intersection of the flight and the bottom of the channel in the same manner as the C2F.

These screws are referred to as self-wiping or self-cleaning screws because of the close proximity between the screws themselves and the wall of the barrel.

25 The temperature profile along the barrel for both T2 and T3 was as follows:

<u>Zone</u>	<u>Approx. Temp. (°C)</u>	<u>Time Per Zone (sec.)</u>
1 (feed)	25	5
2	40	5
3	45	5
30 4	45	5
5	200	5
6	200	5
Die	195	Exit

35 The die temperature of the extruder is about 175 to about 225°C and, more preferably, about 190 to about 200°C. Good results have been obtained at a die temperature of about 195°C. The temperature along the

barrel is important. The feed starts at room temperature, about 25°C, and proceeds down the barrel such that during the last about 10 to about 15 seconds before exiting the die the starch is subjected to a 5 temperature substantially similar to the die temperature, i.e. about 175 to about 225°C, with good results at about 195°C. Preferably, the feed starch is raised to a temperature starting at room temperature up to about 125 to about 150°C during the first about 10 to about 20 10 seconds in the barrel.

The operating conditions of the extruder impart a very high shear to the starch granule and cause the granular structure of the starch to be completely destroyed. It also causes a reduction in the molecular 15 weight of the starch polymers.

One convenient way to characterize the degree of conversion is to measure the reducing sugar content of the converted starch. Conventionally, the reducing sugar content of a starch product is measured by determining 20 the Dextrose Equivalent (DE) of the product. DE is an indication of the total reducing sugars calculated as D-glucose on a dry weight basis. DE is inversely related to the degree of polymerization (DP) or molecular weight of the starch. For example, waxy maize starch has a DP 25 of around 28,000 and a DE of 0, while glucose has a DP of 1 and a DE of 100.

The DE of the converted, high amylopectin starch used in the present invention is less than about 1 and, more preferably, about 0.1 to about 0.2. The DE is 30 measured using a Nelson procedure as reported in the *Journal of Biological Chemistry* 153 (1944) pgs. 375-380 employing 1 gram of converted starch in 100 grams of water.

It has been found that the converted, high 35 amylopectin starch used in the present invention when added to water produces aqueous solutions with good stability and clarity. Specifically, an aqueous solution

containing 10% by weight converted, high amylopectin starch has an initial clarity of greater than about 80%T when measured spectrophotometrically at 650  $\mu\text{m}$  through a 1 cm cell at room temperature; and a long term clarity of greater than about 80%T after three days of storage at 4°C when measured spectrophotometrically at 650  $\mu\text{m}$  through a 1 cm cell at room temperature.

Furthermore, when the converted, high amylopectin starch is made from the hydroxypropylated crosslinked, high amylopectin starch, an aqueous solution containing 10% by weight of the converted, high amylopectin starch has a clarity greater than about 80%T after 14 days of storage at 4°C.

These and other aspects of the present invention may be more fully understood by reference to one or more of the following examples.

#### EXAMPLE 1

This example illustrates making the converted, high amylopectin starch used in the present invention from both a dull waxy corn starch and a hydroxypropylated, crosslinked dull waxy corn starch.

Using a Clextral BC45 extruder having the screw design of T3, converted starch was made by operating the extruder under the following conditions:

25	Die Temperature (°C)	195
	Residence Time (sec.)	25-30
	Moisture (Starch, %)	18
	SME (KJ/Kg)	900

The hydroxypropylated, crosslinked dull waxy corn starch was prepared from propylene oxide in an amount of 2.5% on the starch (DS of 0.07) and a degree of crosslinking with phosphorous oxychloride of 0.035%. Such a starch is commercially available from Cerestar USA, Inc. of Hammond, Indiana.

The dull waxy corn starch was in granular form and is commercially available from Cerestar USA, Inc.

Both converted, high amylopectin starches had the

following characteristics:

5

DE	0.1-0.2
Clarity initial	89%T
Clarity long term (3 days, 4°C)	89%T

10

The converted, high amylopectin starch made from the chemically modified granular, high amylopectin starch had a clarity of greater than 80%T after 14 days of storage at 4°C. The DE was measured by the Nelson method referred to above. The clarity was measured spectrophotometrically of a 10% solids solution.

EXAMPLE 2

15

This example compares the initial clarity of a number of aqueous solutions which contain various low DE converted starches. The various aqueous solutions and their intial clarity are listed below:

<u>Converted Starches</u>	<u>Initial Clarity (%T)</u>
Converted Starch of Example 1	89
Conventional Converted Starch (1 DE)	24
Maltodextrin (5 DE)	92

20

The conventional converted starch was made by the action of alpha amylose on a starch slurry. The maltodextrin was a waxy corn starch maltodextrin prepared by the action of alpha amylose on a starch slurry. The clarities were measured spectrophotometrically at room temperature through a 1 cm cell at 650  $\mu$ m. Each solution had a solids content of 10% by weight.

25

EXAMPLE 3

This example compares the long term clarity of an aqueous solution which contains various low DE converted starches. The various aqueous solutions and their long term clarity are listed below.

30

<u>Converted Starches</u>	<u>Long Term Clarity (%T)</u>
Converted Starch of Example 1	89
Conventional Converted Starch	opaque (0)

These tests were conducted after the aqueous solutions had been stored for three days at 4°C. The solutions were measured in the same manner as Example 2 above and correspond to the two solutions from Example 2 above which were refrigerated after measuring the initial clarity.

EXAMPLE 4

This example compares a gelatin-type dessert made with the converted, high amylopectin starch made in accordance with Example 1 above to a conventional commercial brand gelatin dessert, and to a gelatin-type dessert made with a non-extruded, hydroxypropylated, crosslinked waxy corn starch.

To make a gelatin dessert the following formulations were employed:

<u>Ingredient</u>	<u>Percent by Weight</u>	
	<u>Desert A</u>	<u>Dessert B</u>
Converted starch	4.0	-
Chemically modified starch	-	4.0
20 Carrageenan	0.5	0.5
Sweetener (TRU-SWEET 55)	6.6	6.6
Water	84.9	84.9

The formulations A and B were cooked up and chilled. The commercial brand was prepared in accordance with the instructions on the box. The commercial brand contained gelatin.

Dessert A was made with converted dull waxy starch made in accordance with Example 1 above, while Dessert B was made with non-extruded, hydroxypropylated, crosslinked waxy corn starch having the same degree of crosslinking and DS as the modified dull waxy starch used in Example 1 above to make the converted, high amylopectin starch.

The three dessert puddings were then compared. In a visual observation, both the commercial dessert and Dessert A were crystal clear to the eye. Dessert B was cloudy. To determine gel strength, the desserts were cut

with a knife. The commercial dessert and Dessert A were rated very firm. Dessert B was weak. Next, the desserts were rated for cutability. This is the ability of the knife to cut smoothly through the dessert. Dessert A and the commercial dessert were rated very good. Dessert B was bad. Next, the three desserts were subjected to a taste panel. Dessert B had a chemical flavor and was also found to have a starchy flavor. Dessert A had no starchy flavor and no chemical flavor. The commercial brand had a clean flavor that was not starchy.

EXAMPLE 5

This example compares the converted dull waxy starch made by extrusion in accordance with Example 1 above in a doughnut glaze to a conventional doughnut glaze made with a carboxymethyl cellulose, a gum. Doughnuts were glazed with the following formulations:

		<u>Percent by Weight</u>	
		<u>Present Invention</u>	<u>Conventional</u>
	Converted Starch	4.0	-
20	Gum	0.2	0.85
	Powdered Sugar (6X)	66.85	66.85
	Potassium sorbate	0.1	0.1
	Water	28.85	32.2

To make these formulations, first the gum was hydrated in the water, then the converted, high amylopectin starch added (present invention formulation only). The water mixtures were then heated to 70°C and allowed to cool to 25°C at which time the powdered sugar and potassium sorbate was added.

It was found that the doughnut glaze made with the converted, high amylopectin starch produced a glaze equal to that of the conventional doughnut glaze made with 100% gum.

EXAMPLE 6

This example compares a honey based doughnut glaze made with the converted, dull waxy starch made in accordance with Example 1 above to a honey based doughnut

glaze made with carboxymethyl cellulose, a conventional gum. To make the bases for the two glazes, the following formulations were employed.

Honey Base

		<u>Percent by Weight</u>	
		<u>Present Invention</u>	<u>Conventional</u>
5	Converted starch	7.8	-
	Gum	-	approx. 3
	Sugar	49.	49.
10	Water	35.25	40.05
	Citric Acid	0.05	0.05
	Honey	7.8	7.8
	Potassium Sorbate	0.1	0.1

15 To the acidified water, the converted, high amylopectin starch/sugar or gum/sugar was added and heated to 70°C, once the mixture cooled, the honey and potassium sorbate were added.

20 Two glazes were made, one with the converted, high amylopectin starch and one without from the honey base prepared above using the following formulation for each.

Honey Glaze

	<u>Ingredients</u>	<u>Percent by Weight</u>
	Honey base	51
	Sugar (6X)	10
25	Water	39

To make the glaze, the ingredients were combined and then whipped into a glaze.

When the two glazes were compared, the honey glaze made with the converted, high amylopectin starch had better clarity to the eye, less opaque than the glaze made with the gum. Both glazes had similar flow characteristics and the two glazes had similar viscosities, 1500 cps. Brookfield Viscosity for the glaze made with the converted, high amylopectin starch, as opposed to 1700 cps Brookfield Viscosity for the glaze made with the gum. The flavor of the two glazes was essentially the same to a taste panel, but the glaze made

with the converted, high amylopectin starch cleared from the palate before the conventional glaze.

One of the features of a honey glaze compared to a conventional doughnut glaze, e.g. Example 5, is stability. A honey glaze should be stable over long periods of time either in a refrigerator and at room temperature. It was found that a honey glaze made with the converted, high amylopectin starch was stable for 60 days after storage at 4°C. Thus, the stability of the honey glaze made with the converted, high amylopectin starch is comparable to a conventional honey glaze made with a gum.

#### EXAMPLE 7

This example compares a clear pastry glaze made with the converted dull waxy starch made in accordance with Example 1 above to a conventional clear pastry glaze made with pectin. Both formulations also contained carrageenan, a natural gum. The two glazes had the following formulations.

	<u>Ingredients</u>	<u>Percent by Weight</u>	
		<u>Present Invention</u>	<u>Conventional</u>
	Pectin	0	5.6
	Carrageenan (Kappa)	0.36	0
	Carrageenaan (Iota)	0.24	0
25	Converted starch	10.00	0
	Pulverized Sugar	20.00	20.00
	Water	69.40	74.40

To prepare the glazes, the dry ingredients were blended and then heated in the water to a boil. The glaze was allowed to cool to 55°C before applying it to cold fruit. The glazed fruit was then refrigerated.

The two glazes were found to have the same clarity to the eye. It was also found that the glaze made with the converted, high amylopectin starch formed a quicker film on the fruit than the conventional pectin glaze.

EXAMPLE 8

5 This example illustrates the use of the converted, dull waxy starch made in accordance with Example 1 above in ice cream to replace a gum and prevent ice crystal growth.

Conventionally, ice creams use a gum such as agar, locust bean, guar gum, xanthan, carboxymethyl cellulose and carrageenan to prevent or retard ice crystal growth.

10 It was found that the converted, high amylopectin starch when used in ice cream in place of the natural gum functioned to prevent ice crystal growth better than a control which was made with locust bean gum. The conventional ice cream was made with a formulation containing 0.3% by weight of a gum formulation comprising 15 locust bean gum and carrogeenan, while the ice cream made in accordance with the present invention used the same formulation except the gum formulation was replaced with 0.65% by weight of a converted dull waxy starch made in accordace with Example 1 above.

20 Both ice creams had similar Brookfield viscosities and were comparable in appearance, body, flavor, and overrun.

EXAMPLE 9

25 This example illustrates using the converted, high amylopectin starch made in accordance with Example 1 to replace a natural gum in a light fruit spread. The table below illustrates the formulation of both spreads:

	<u>Ingredients</u>	<u>Percent by Weight</u>	
		<u>Present Invention</u>	<u>Conventional</u>
	Strawberries	61.00	61.00
30	Sugar	22.12	22.12
	Pectin	0.83	0.83
	Locust Bean Gum	-	0.12
	Converted Starch	0.12	-
	Potassium Sorbate	0.30	0.30
35	Citric Acid	0.24	0.24
	Calcium Chloride	0.45	0.45
	Coloring	0.30	0.30

To make the two spreads, the strawberries and water were mixed with the pectin, a portion of the sugar and locust bean gum or converted, high amylopectin starch. This mixture was brought to a boil and the remaining sugar added and the boiling continued for 2 minutes. Finally, the remaining ingredients were added and the mixture poured into jars to set.

Both gel strength and taste were found to be comparable by a taste panel. The panel, however, found the light fruit spread made with the converted, high amylopectin starch to have improved spreadability. In addition, after storage at 4°C for one month, the spread with the converted, high amylopectin starch was glossier and, after the spread was disturbed and then re-refrigerated for periods as brief as 24 hours, displayed significantly less syneresis than the spread made with all natural gums. The addition of the converted, high amylopectin starch yields not only a cost advantage but a product with less tendency to syneresis and a product with improved spreadability.

It will be understood that the claims are intended to cover all changes and modifications of the preferred embodiments of the invention herein chosen for the purpose of illustration which do not constitute a departure from the spirit and scope of the invention.

## CLAIMS

1. A method for preparing a foodstuff wherein said foodstuff is prepared from a formulation containing a foodstuff, and a natural gum, the improvement comprising replacing at least a portion of said natural gum with water and an effective amount of a converted starch characterized by having a dextrose equivalent of below about 1, said converted starch being obtained from a high amylopectin starch which has been extruded at a specific mechanical energy of about 600 to about 1050 KJ/Kg, said converted starch being devoid of granular structure, said converted starch producing an aqueous solution when added to water having an initial clarity of at least about 80%T at about 10% solids, when measured spectrophotometrically at 650  $\mu$ m through 1 cm cell.

2. The method of claim 1 wherein said converted starch has a DE of about 0.1 to 0.2

3. The method of claim 1 wherein the high amylopectin starch is selected from the group consisting of dull waxy starch, waxy starch, chemically modified dull waxy starch, and chemically modified waxy starch.

4. The method of claim 3 wherein said chemically modified dull waxy starch is a crosslinked hydroxypropylated dull waxy starch and said chemically modified waxy starch is a crosslinked hydroxypropylated

waxy starch.

5. The method of claim 4 wherein the starch is obtained from maize.

6. The method of claim 4 wherein said crosslinked hydroxypropylated dull waxy starch has a DS of about 0.056 to about 0.126 and is crosslinked with a phosphorous oxychloride to a level of about 0.03 to about 0.06; and said crosslinked hydroxypropylated waxy starch has a DS of about 0.056 to about 0.126 and is crosslinked with phosphorous oxychloride to a level of about 0.03 to about 0.06.

7. The method of claim 1 wherein said starch prior to extrusion has a moisture content of about 15% to about 25% by weight dry starch.

8. The method of claim 1 wherein said effective amount is about 1 to about 1/3 by weight the amount of natural gum in the foodstuff.

9. The method of claim 1 wherein the foodstuff is selected from the group consisting of gelatin-type puddings, doughnut glazes, clear pastry glazes, ice cream, yogurt, sour cream, and candy coatings.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US96/10707

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A23G 3/30

US CL :426/3

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 426/3, 4, 5, 6, 578, 658

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

search terms: chewing gum, waxy starch, converted starch

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 3,632,425 (GRAHAM ET AL) 04 January 1972.	1-9
A	US, A, 3,865,603 (SZYMANSKI ET AL) 11 February 1975.	1-9
A	US, A, 5, 512,311 (CAPITANI ET AL) 30 April 1996.	1-9
A	US, A, 5,185,176 (CHIU) 09 February 1993.	1-9
A	US, A, 5,279,844 (WESDORP ET AL) 18 January 1994.	1-9

 Further documents are listed in the continuation of Box C. See patent family annex.

## \* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"A"

document member of the same patent family

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